# Comments on "Draft Guidance For Evaluating The Vapor Intrusion to Indoor Air Pathway From Groundwater And Soils (Subsurface Vapor Intrusion Guidance)"

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Submitted to:

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## Introduction

The following comments on the "Draft Guidance For Evaluating The Vapor Intrusion to Indoor Air Pathway From Groundwater And Soil" (referred to below as the Draft Guidance) are submitted pursuant to the Federal Register Notice of November 29, 2002 (67FR71169).

## Comment #1

The Draft Guidance contains significantly flawed science. This is a result of its heavy dependence on the Johnson and Ettinger model (JEM) that is, itself, fundamentally flawed. The JEM is used in two important screening steps in the Draft Guidance, namely, the so-called "semi-site specific screening" and the "site specific screening" steps.[1] The JEM was used by EPA to calculate attenuation factors for the development of "semi-site specific target media concentrations" (pp. 34 and G-4). The JEM is also a model that EPA indicates may be used as a "site-specific tool" (p. G-8).

[1] Unfortunately, the terminology for differentiating steps in the screening process is very confusing and, at times, inconsistent. Particularly troublesome is the interchangeable use of the terms 'tier' and 'screening' throughout the document (see p. 7, First Tier and Second Tier with Primary Screening and Secondary Screening ). The Guidance itself appears to get confused with the terminology when it says "[t]his appendix provides guidance for the model's use as both a first-tier screening level tool…" (p. G-1). It seems like it should say "second-tier." It is recommended that the entire terminology be reworked to be simpler, less confusing, and consistent.

The fundamental deficiency of the JEM (both as formulated by Johnson and Ettinger[2] *and* as used by EPA) is that it does not account for the sorption of contaminants by the solid soil matrix as contaminants move from groundwater or soil sources through the vadose (unsaturated) zone to indoor air. That is, the model treats partitioning in the vadose zone as *only a two-phase system* – soil moisture phase and soil vapor phase. Of course, it is well known that a third phase, the solid soil matrix (made up of organic and mineral matter) exists in the vadose zone. In fact, the solid phase is by far the dominant phase by volume and mass. It is also the phase that often most affects the fate and transport of contaminants in the subsurface. Yet the JEM disregards one of the most important affects (i.e., sorption) this phase has on the fate and transport of contaminants in the vadose zone. Doing so flies in the face of a wealth of knowledge concerning the vadose zone.

Many organic contaminants (including volatile organic contaminants – VOCs) partition to, and accumulate in, the soil solids phase. For many contaminants the soil solids phase is the overwhelmingly predominant sight of sequestration. This has been shown empirically and by simple equilibrium partitioning analysis. The American Society for Testing and Materials (ASTM), in its Standard Guide for Risk-Based Corrective Action (RBCA, E 2081-00) has shown that for many organic contaminants, including VOCs, as much as 90% (sometimes more) of the contaminant is sorbed to the soil solids phase (see the equilibrium soil partitioning plots in Table X3.1 of the Standard). This is true for such important and common contaminants as tetrachloroethylene ("perc") and benzene. NOTE: The ASTM partitioning analysis is based on soil with a low organic fraction ($f_{oc}$) value of 0.01. Soils commonly have $f_{oc}$'s greater than 0.01. Higher $f_{oc}$ values result in even greater sorption of organic contaminants to the soil solids phase. By ignoring the sorption phenomenon the JEM acts as if this near 90% of soil-sorbed contaminant is entirely in the soil vapor and soil moisture phases when, in fact, it is not. There is nothing "reasonable" about doing so.[3]

This disregard of soil sorption stands in stark contrast to the rest of the modeling world. The commenter is unaware of any other model dealing with vadose zone fate and transport, *including any EPA model*, which disregards the affects of soil sorption of organic contaminants. The JEM, and by extension the Draft Guidance, appears to stand quite alone in its decision to disregard what every other model deems important. In its entire 177 pages, the Draft Guidance's only mention of the important sorption phenomenon is buried in a single statement in an appendix: "Neither sorption nor biodegradation is accounted for in the transport of vapor from source to the base of the building." (p. G-2) This casual dismissal of a likely controlling phenomenon is, at the least, disingenuous.

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[2] *Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings*, P.C. Johnson and R.A. Ettinger, **Environmental Science and Technology**, 25, 1445-1452 (1991).

[3] The Draft Guidance repeatedly uses the term "reasonable" to characterize the assumptions and approaches employed in the guidance. Absent any clear statement of what constitutes "reasonable" the characterization exists simply as an unsubstantiated assertion. Examples include: generally reasonable conservative screening approaches, p.1; reasonable worst-case conditions, pp.8 and 21; reasonable conclusion, pp.9, 38, 40, and 42; reasonable upper bound [sic] values, p. 28; reasonably conservative [source depth and soil type], pp. 34 and G-3; generally reasonable building characteristics, p. 34; generally reasonable model inputs, p. G-3; and, reasonably (but not overly) conservative estimate, p. G-4.

The affect of disregarding soil sorption is to potentially significantly overestimate the flux of contaminants into buildings. This will result in inestimable numbers of sites that would otherwise be considered as "Pathway Incomplete" being required to undergo further evaluation with associated increased expenditure of resources and time. The argument that screening processes need to be conservative cannot be an excuse for careless science. *"Reasonable" conservatism does not entail the wholesale disregard of common knowledge.*

EPA should incorporate the affects of soil sorption into its calculated attenuation factors and into its formulation of the JEM. Failing that, EPA should clearly explain in the Draft Guidance why it is reasonable to disregard the consideration of soil sorption in this particular vadose zone screening model while including its consideration in every other EPA vadose zone screening model.

**Comment #2**

When reviewing earlier drafts of the guidance the commenter urged EPA to include justifications for 1) all of its assumptions and, 2) its development and selection of all recommended default model inputs. With the Draft Guidance, EPA has provided some justifications. EPA appears to have used a soil temperature of 25 $^{o}$C as a default input for calculating attenuation factors used to derive "semi-site specific target media concentrations." As a result of the temperature dependence of Henry's Law Constant both attenuation factors and target groundwater concentrations are temperature dependent.[4] To the commenter's knowledge, no soil in the continental United States has a mean annual temperature as high as 25 $^{o}$C. In fact, the Technical Background Document for EPA's Soil Screening Guidance indicates that a significant portion of continental United States soil has temperatures as much as 10 $^{o}$C (or more) lower than 25 $^{o}$C.

Flux of contaminants to indoor air increases as soil temperature increases. Use of an unrealistic soil temperature may contribute to sites that would otherwise be considered "Pathway Incomplete" being forced to undergo additional evaluation with attendant additional expenditure of resources and time. The use of numerous so-called "reasonable" worst-case inputs or assumptions, even if the affects of individual inputs or assumptions is small, can have the overall affect of "reasonableness" stealthily and insidiously converting to unreasonableness and eventually winding up as absurdity.

EPA should indicate in the Draft Guidance what soil temperature was used as a default input for calculating attenuation factors and semi-site specific target media concentrations. EPA should justify the selected temperature. If EPA uses a soil temperature of 25 $^{o}$C it should explain why a soil temperature apparently not found anywhere in the continental United States represents a "reasonable" default input.

**Comment #3**

The Draft Guidance, at page 29, says:

[4] Attenuation factor inputs of contaminant diffusivity in air and water are temperature dependent as well. The Draft Guidance does not address this fact.

> Soil (as opposed to soil gas) sampling and analysis is not currently recommended for assessing whether or not the vapor intrusion pathway is complete. This is because of the large uncertainties associated with measuring concentrations of volatile contaminants introduced during soil sampling, preservation, and chemical analysis, as well as the uncertainties associated with soil partitioning calculations. Thus, bulk soil target concentrations were not derived and the use of bulk soil target concentration is not generally recommended.

EPA is strongly warned that this wholesale dismissal of VOC soil sampling and analysis may have serious repercussions. The writers of the Draft Guidance should consult other EPA programs, *as well as EPA lawyers*, as to whether EPA wishes to be officially on record with such dismissive and disparaging language. Many EPA programs, not the least of which are the RCRA and CERCLA programs, rely heavily on "measuring concentrations of volatile contaminants" in soil and "the use of bulk soil target concentration[s]." For example, EPA's Soil Screening Guidance relies extensively on the sampling and analysis of VOCs in soil and the associated use of bulk soil target concentrations.

EPA and the scientific community have greatly improved the sampling and analysis of soils for VOCs. In fact, EPA's RCRA corrective action program has endorsed new and improved methodology in this area (see the Directive for Change at http://www.epa.gov/RCRIS-Region-5/ca/directive.htm). It is recommended that *all* language dismissive of soil sampling and analysis be removed from the Draft Guidance.

**Comment #4**

The Draft Guidance should reference specific original (source) literature for the values in Table G-4.